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**Solar Wind Input into the Magnetosphere: Assimilation of Multi-Spacecraft Data**

The primary objective of this proposal is the reconstruction of the solar wind and IMF shear and gradients perpendicular to the Sun-Earth line by assimilating data from multiple solar wind monitors. This will allow the consideration of asymmetrical or non-uniform solar wind input into the magnetosphere based on multi-spacecraft data that is magnetohydrodynamically self-consistent. NOAA has been using L1 solar wind observations from ACE, and previously from WIND and ISEE-3, with considerable success to forecast geo-effective events with an approximately 45-minute warning time. However, there is still a significant rate of false alarms and some potentially dangerous events are missed all together. This proposal aims to enable better understanding of the solar wind input into the magnetosphere as a result of modern data assimilation techniques to reconstruct the variable solar wind profile across the magnetospheric cross-section in a more realistic manner using already available data from ACE, WIND, IMP 8, Geotail and Interball-1. The first portion of this study will implement data assimilation techniques (statistical interpolation) widely used in the meteorological community on the various data sets and the 3-D MHD numerical model ENLIL of the solar wind. The reconstructed transverse profile of the solar wind will be compared with observations near/inside the Earth's magnetosphere in order to estimate the gains in prediction accuracy of magnetospheric events. As a further refinement of the assimilation process, the shapes and orientations of the interplanetary shocks/discontinuities will be taken into account. The detailed knowledge of the transverse solar wind profile across the magnetospheric cross-section, which will be provided by the technique developed in this study, will allow the development of better understanding of the Sun-Earth interactions and will result in more accurate space weather predictions. In summary, this work will employ modern data assimilation techniques to reconstruct the solar wind profile, compare the results, based upon as many as five spacecraft, with single spacecraft observations and thus provide scientific guidance for future L1 multi-spacecraft concepts, as well as mission concepts for monitoring space weather conditions, one of the main goals of the NASA LWS program. This proposal aims to develop new techniques that will increase the utility of multiple spacecraft observing the solar wind as a single observatory.